International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(7): 373-379
www.biochemjournal.com
Received: 24-04-2024
Accepted: 04-06-2024

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Effect of different levels of inorganic fertilizers and NPK liquid consortia on soil health and yield attributes of green gram (*Vigna radiata* L.) *Var* moong Samrat 139

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DOI: https://doi.org/10.33545/26174693.2024.v8.i7e.1497

Abstract
The experiment was conducted to access the "Effect of different levels of NPK fertilizers and Liquid consortia on soil health and yield attributes of green gram (*Vigna radiata* L.) *var*. Samrat-139" on central research farm in Sam Higginbottom University of Agricultural, Technology and Sciences, Prayagraj. The experiment was laid out in factorial randomized block design with three levels of NPK Fertilizers (0%,50%and100%) and three levels of liquid consortia (0%,50% and 100%). The results showed that the soil properties, growth and yield of green gram were significantly affected by the application of different levels of NPK and Liquid consortia. The highest growth and yield were observed in T_9 [NPK @100% + Liquid consortia @100%], followed by T_6 [NPK @50% + Liquid consortia @100%], whereas the lowest growth and yield observed in T_1 [NPK @0% + Liquid consortia @ 0%]. The combined application of NPK and Liquid consortia significantly improved soil properties, including decrease in pH, and an increase in percentage pore space, water holding capacity, available Nitrogen, Phosphorus and Potassium. Therefore, it is recommended to use a combination of NPK and Liquid consortia to improve soil health and enhance green gram growth and yield.

Keywords: Samrat-139, liquid consortia, inorganic fertilizers, green gram, soil health, yield

1. Introduction
The botanical name is Greengram (*Vigna radiata* L. *Wildzek.*) Family: Leguminosae, area and distribution of Greengram in various nations like India, Burma, Sri Lanka, Pakistan, China, Fiji, Queens Land, and Africa. Green gram, also known as moongbean, is consumed as a whole grain and in dal. It belongs to the fabaceae botanical family and the genus Vigna with chrmosome no. 2n=22 (Kumar *et al.*, 2012) [1]. Moong bean is a traditional pulse crop grown in India's diverse agro-climatic zones. The seeds include 24.7% protein, over 2.5-3.0 times higher than grains, 0.6% fat, 0.9% fiber, and 3.7% ash (Abbas *et al.*, 2011.) [2]. It was introduced in southern China, Indonasia and Java. In recent times, it has been introduced into East and central Africa, the West Indies and the United States. Plant is annual, herbaceous, erect or semi-erect,45-120 cm tall straight pods around 10 cm long. In India, greengram (mungbean) occupies 3.3 million ha area and contribution to 1.1 million tonnes in pulse production. Moong thrives well at 25 -35 °C. Greengram is cultivated on a wide variety of soils, ranging from sandy to heavy loam. (Handbook of agriculture).
Insufficient nitrogen and phosphorus availability during crop flowering and pod formation can cause shading of flowers and pods. The optimal nitrogen and phosphorus input affects green gram growth and yield (Rathod and Gawande, 2012) [3]. Nitrogen fertilizers are vulnerable to rising costs in non-renewable fossil fuels, notably natural gas, due to the energy-intensive process of breaking triple-bonded diatomic atmospheric nitrogen (Roberts and Vitousek, 2009) [4]. Adequate phosphorus in soil promotes quick plant development, early fruiting, and enhances produce quality (Rathore *et al*., 1992) [5].
Bio-fertilizers can be regarded eco-friendly, non-hazardous, and nontoxic products, and increasing the availability of nutrients to crops resulted in increased production (Bashan *et al*., 2004; Sharma *et al*., 2007) [6, 7]. Biofertilizers improve soil fertility by fixing atmospheric

nitrogen through plant roots. They convert insoluble soil phosphates into soluble forms and generate plant growth material in the soil. Potassium-solubilizing bacteria transform unavailable potassium into a form that plants can absorb (Behera and Rattray 2010) [7].

2. Materials and Methods

2.1 Experimental Site and Location

The field study was conducted at the research farm of Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, Sam Higginbottom university of Agriculture Sciences, Technology and Sciences in Prayagraj district of Uttar Pradesh. The site is situated a latitude of 25°24'30" N and longitude of 81°51'10" E, with an elevation of 98 meters above mean sea level and 4-5 km away from the city on the right bank of Yamuna River. This location representing Argo-ecological Sub Region [North Alluvium plain zone (0-1% slope)] and Agro- Climatic Zone (Upper Gangetic Plain Region).

2.2 Climate condition

Argo-climatically, Prayagraj district of Uttar Pradesh represents the sub-tropical belt of the South-East Uttar Pradesh and is endowed with extremely hot summer and fairly winter conditions. In the winter period, notably in December to February, temperatures can plummet to as little as 3-5 degrees Celsius. Conversely, during the summer months, temperature soar to levels surpassing 46-48 degrees Celsius. The relative humidity ranges between 20-94%. The summer season is marked by the prevalence of intense, searing winds, while occasional frost occurrences can be observed in winter. The average rainfall of this area around 1100 mm annually, primarily concentrated in the monsoon phase spanning from July to September, with intermittent rainfall events taking place during the winter months.

Table 1: Symbolic presentation of treatment combination

Treatment	Treatment Combination	Symbols
T_1	@0%NPK + 0%Liq. Cons.	N_0L_0
T_2	@0%NPK + 50%Liq. Cons.	N_0L_1
T_3	@0%NPK + 100%Liq. Cons.	N_0L_2
T_4	@50%NPK + 0%Liq. Cons.	N_1L_0
T_5	@50%NPK + 50%Liq. Cons.	N_1L_1
T_6	@50%NPK + 100%Liq. Cons.	N_1L_2
T_7	@100%NPK + 0%Liq. Cons.	N_2L_0
T_8	@100%NPK + 50%Liq. Cons.	N_2L_1
T_9	@100%NPK + 100%Liq. Cons.	N_2L_2

2.3 Experimental Details

Experiment was laid out in 3x2 factorial randomized block design with inorganic fertilizers and liquid consortia with three different levels of NPK and liquid consortia @ 0, 50 and 100% ha^{-1} having nine treatment combinations which is replicated thrice, randomly allocated in each replication, dividing the research site into 27 plots. In this study, inorganic fertilizers like Nitrogen, Phosphorous, Potassium, were used as RDF and liquid consortia was applied in three different doses. Sowing of green gram crop was carried out on 18th of april month during 2023 respectively by manually. Seed variety PDM-139 (Samrat) was sown at the rate of 25 kg ha^{-1} and at a row to row spacing of 25 cm and plant to pant spacing 10 cm.

2.4 Fertilizer Application

Recommended dose of NPK 10:20:20 (100%) was applied to the green gram were N (10 kg ha^{-1}), P2O5 (20 kg ha^{-1}) and K_2O (20 kg ha^{-1}).

The 100 percent application of N in 2 splits but P, K were used as basal dose at the time of sowing. In adding to these applications, liquid consortia was used as basal @ 0,0.432 and 0.864 Lt ha^{-1}. The sources of NPK fertilizers were Nitrogen through urea (46% N_2O) Phosphorus through diammonium phosphate (46% P_2O_5 and 18%N), Potash through Muriate of Potash (60% K_2O) were applied earlier to sowing in regarding treatments just before the seed sowing. Nitrogen through urea (46% N), were applied in 2 different doses.

2.5 Layout and treatment combination

Experiment was laid out 3x2 factorial randomized block design (FRBD) with inorganic (NPK) and organic (Liquid consortia) with three different levels of NPK @ 0,50 and 100% ha^{-1}. Treatment were T_1 - @N0P0K0 kg ha^{-1}, T_2 -@ N0P0K0kg ha^{-1} + LC@0.432Lt, T_3 -@N0P0K0kg ha^{-1} +LC@0.864Lt,T_4 - @N5P10K10 kg ha^{-1} + LC@0Lt,T_5-@N5P10K10 kg ha^{-1} + LC@0.432Lt, T_6-@N5P10K10 kg ha^{-1} + LC @0.864Lt,T_7 - @N10P20K20 kg ha^{-1} + LC@0%, T_8 - @N10P20K20 + LC@0.432Lt and T_9 - @N10P20K20 kg ha^{-1} + LC@0.864Lt. Nitrogen was applied in two split doses. The source of NPK in inorganic source were urea, DAP and MOP and for organic was liquid consortia.

2.6 Soils Analysis

The soils from each plot were separately collected, air-dried, ground and passed through 2 mm size sieve for laboratory analysis. Soil samples were analyzed for Bilk density, particle density, pore space, water holding capacity (WHC) using 100 ml measuring cylinder [8], pH [10], EC [11], Organic carbon and Organic matter by [12], and Available Nitrogen [13] Available P [14] Available Potassium [15] before sowing the experimental crop and after the harvest of crop.

2.7 Statistical analysis

The observation data recorded during the investigation will be subjected to statistical analysis by factorial randomised block design (FRBD) with total twenty seven plots with three dosages of inorganic fertilizers (0, 50 and 100%) and liquid consortia (0, 50 and 100%) and the treatment was replicated three times, as per the method "Analysis of Variance (ANOVA) technique". The significant and non-significant effect was judged with the help of "F" (variance ratio) table. The significant difference between the means was tested against the critical difference of 5% level. For testing the hypothesis, the following ANOVA table was used Fisher (1950).

3. Results And Discussion

3.1 Effect of inorganic fertilizers and liquid consortia on Physical properties of soil after Harvest of green gram

The effect of liquid consortia on water holding capacity of soil at 0-15 cm and 15-30 cm depth was found significant. The maximum water holding capacity 42.89% and 41.41% was found in 100%LC and minimum water holding capacity 39.83% and 38.63% was observed in 0%LC.The interaction effect of inorganic fertilizers and liquid consortia on water holding capacity was found non-significant at 5% critical difference. The effect of inorganic fertilizers on pore space of soil was found significant at 15-30 cm and non-significant at 0-15 cm depth. The maximum percent pore

space 45.53% and 45.08% in 100%NPK and minimum percent pore space 44.12% and 43.67% was found in 0%NPK.The effect of liquid consortia on percent pore space of soil at 0-15 and 15-30 cm depth was found significant. The maximum 46.86% and 45.86% was found in 100%LC and minimum 43.29% and 42.43% was observed in 0%LC. The interaction effect of inorganic fertilizers and liquid consortia on percent pore space was found non-significant at 5% critical difference.

Table 2: Effect of different levels of Inorganic fertilizers and Liquid consortia on Water holding capacity of soil at 0-15 cm and 15-30 cm depth

	0-15 cm				15-30 cm			
	NPK0	**NPK50**	**NPK100**	**Mean (LC)**	**NPK0**	**NPK50**	**NPK100**	**Mean (LC)**
LC0	39.36	39.67	40.47	39.83	38.23	38.71	38.96	38.63
LC50	40.89	41.69	41.89	41.89	39.52	39.62	40.51	39.88
LC100	42.28	42.41	43.97	42.89	41.03	41.17	42.04	41.41
Mean (NPK)	40.84	41.26	42.11		39.59	39.83	40.5	
	F-test	S.Em(±)	C.D.at 5%		F-test	S.Em(±)	C.D.at 5%	
Due to Inorg. Fertilizer(NPK)	NS	-	-		NS	-	-	
Due to liq. Consortia (LC)	S	0.551	1.65		S	0.337	1.04	
Interaction (NPK+LC)	NS	-	-		NS	-	-	

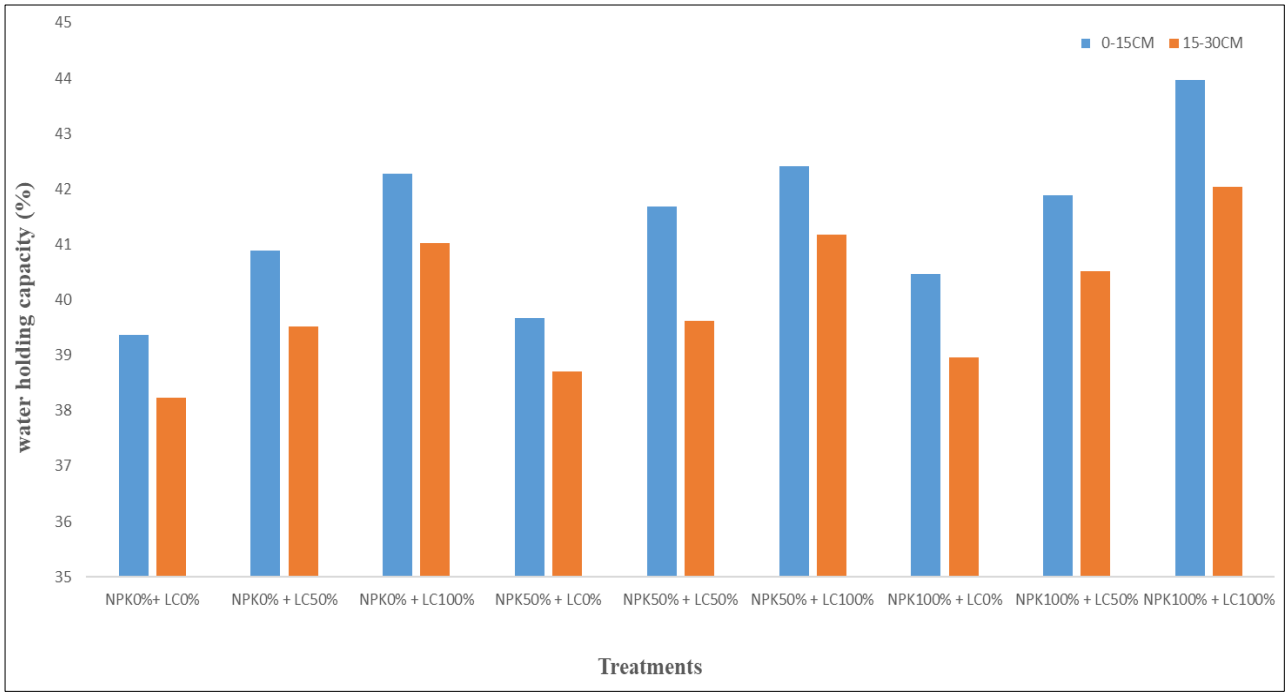

Fig 1: Effect of different levels of Inorganic fertilizers and Liquid consortia on Water holding capacity of soil at 0-15 cm and 15-30 cm depth

Table 3: Effect of different levels of inorganic fertilizers and liquid consortia on percentage pore space of soil at 0-15 cm and 15-30 cm depth.

	0-15 cm				15-30 cm			
	NPK0	**NPK50**	**NPK100**	**Mean (LC)**	**NPK0**	**NPK50**	**NPK100**	**Mean (LC)**
LC0	42.65	43.57	43.65	43.29	41.5	42.44	43.36	42.43
LC50	43.31	44.4	45.38	44.36	44.19	43.19	44.98	44.12
LC100	46.39	46.64	47.56	46.86	45.32	45.37	46.89	45.86
Mean (NPK)	44.12	44.87	45.53		43.67	43.67	45.08	
	F-test	S.Em(±)	C.D.at 5%		F-test	S.Em(±)	C.D.at 5%	
Due to Inorg. Fertilizer (NPK)	NS	-	-		S	0.342	1.02	
Due to liq. Consortia (LC)	S	0.3939			S	0.342	10.02	
Interaction (NPK+LC)	NS	-	-		NS	-	-	

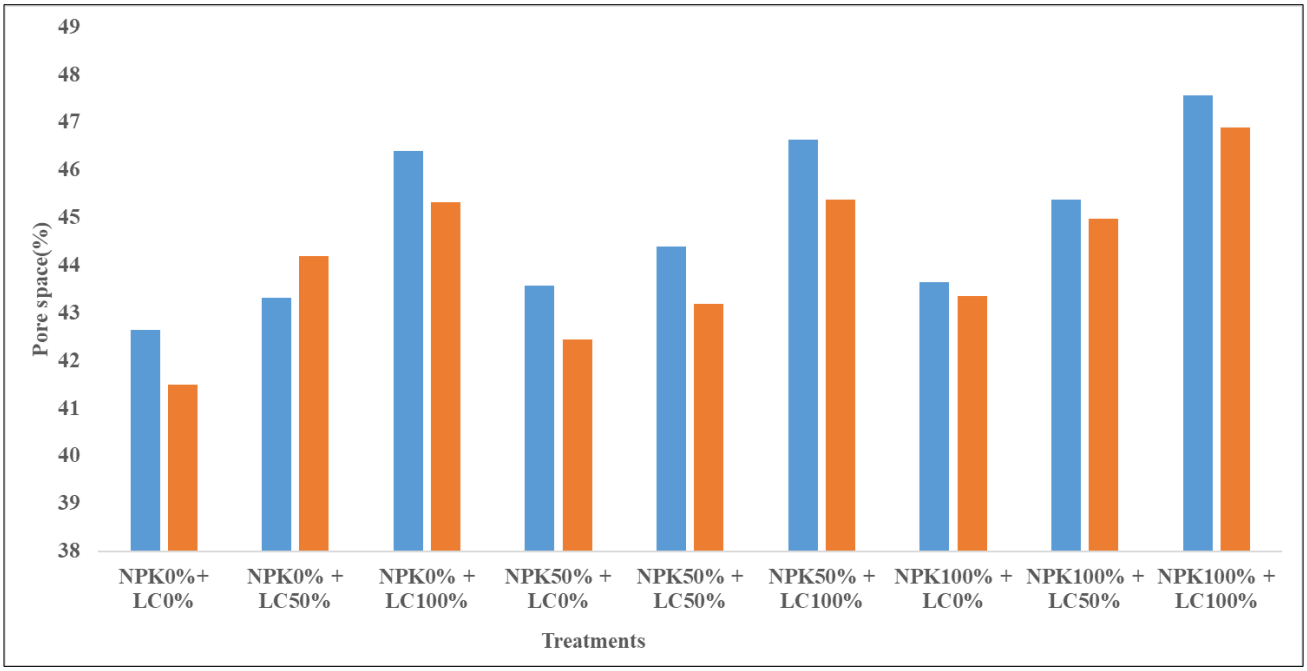

Fig 2: Effect of different levels of Inorganic fertilizers and Liquid consortia on percent pore space of soil at 0-15 cm and 15-30 cm depth

3.2 Effect of inorganic fertilizers and liquid consortia on Chemical properties of soil after Harvest of green gram

The effect of inorganic fertilizers on soil pH of soil was found non-significant at 0-15 cm depth and non-significant on 15-30 cm depth. The effect of liquid consortia on soil pH at 0-15 cm and 15-30 cm was found non-significant. The interaction of inorganic fertilizers and liquid consortia on soil pH was found non-significant at 5% critical difference. The effect of inorganic fertilizers on Available Nitrogen of soil was found significant at 0-15 cm and 15-30 cm depth. The maximum available nitrogen 251.55 and 253.73 kgha^{-1} was found in 100%NPK and minimum 247.42 and 249.88 kgha^{-1}was found in 0%NPK. The effect of liquid consortia on available nitrogen of soil at 0-15 cm and 15-30 cm depth was found significant. The maximum available nitrogen 254.84 and 257.19 kgha^{-1} was found in 100%LC and minimum 244.39 and 246.63 kgha^{-1} was observed in 0%LC. The interaction effect of inorganic fertilizers and liquid consortia on available nitrogen was found non-significant at 5% critical difference. The effect of inorganic fertilizers on available phosphorous of soil was observed significant at 0-15 cm and 15-30 cm depth. The maximum on available Phosphorous 36.42 and 34.51 kgha^{-1} was found in 100%NPK and minimum 32.59 and 31 kgha^{-1} was found in 0%NPK.The effect of liquid consortia on available phosphorus of soil at 0-15 cm and 15-30 cm depth was found significant. The maximum available phosphorus 36.4 and 34.83 kgha^{-1} was found in 100%LC and minimum 32.26 and 30.34 kgha^{-1} was observed in 0%LC. The interaction effect of inorganic fertilizers and liquid consortia on available phosphorus was found non-significant at 5% critical difference. The effect of inorganic fertilizers on Available Potassium kgha^{-1} of soil was observed significant at 0-15 cm and 15-30 cm depth. The maximum available potassium 166.2 and 162.25 kgha^{-1} was found in 100%NPK and minimum 138.53 and 135.01 kgha^{-1} was found in 0% NPK. The effect of liquid consortia on available potassium of soil at 0-15 cm and 15-30 cm depth was found significant. The maximum available potassium 160.26 and 156.71 kgha^{-1} was found in 100%LC and minimum 146.36 and 142.29 kgha^{-1} was observed in 0%LC.The interaction effect of inorganic fertilizers and liquid consortia on available potassium of soil at 0-15 cm and 15-30 cm was found significant at 5% critical difference. The maximum available potassium 169.6 and 165.73 kgha^{-1} was found in T_9 (100%NPK + 100%LC) and minimum 130.58 and 126.64 kg ha^{-1} was observed in T_1 (0%NPK + 0%LC).

Table 4: Effect of different levels of inorganic fertilizers and liquid consortia on soil pH at 0-15 cm and 15-30 cm depth

	0-15 cm				15-30 cm			
Intrc.	**NPK0**	**NPK50**	**NPK100**	**Mean(LC)**	**NPK0**	**NPK50**	**NPK100**	**Mean(LC)**
LC0	7.19	7.13	7.11	7.14	7.21	7.14	7.13	7.16
LC50	7.18	7.14	7.07	7.13	7.2	7.15	7.14	7.14
LC100	7.16	7.09	7.05	7.1	7.17	7.1	7.06	7.11
Mean (NPK)	7.18	7.12	7.08		7.19	7.13	7.09	
	F-test	S.Em(±)	C.D.at 5%		F-test	S.Em(±)	C.D.at 5%	
Due to Inorg. Fertilizer (NPK)	NS	-	-		NS	-	-	
Due to liq. Consortia (LC)	NS	-	-		NS	-	-	
Interaction (NPK+LC)	NS	-	-		NS	-	-	

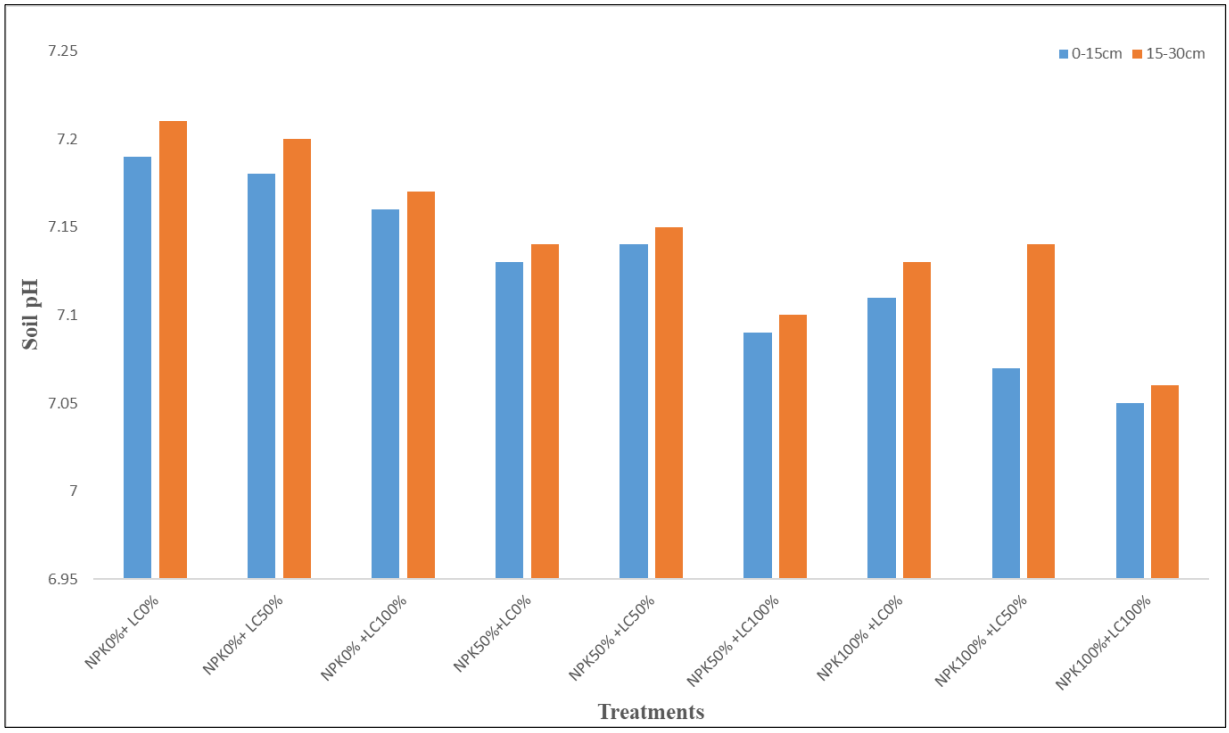

Fig 3: Effect of different levels of inorganic fertilizers and liquid consortia on soil pH at 0-15 cm and 15-30 cm depth

Table 5: Effect of different levels of inorganic fertilizers and liquid consortia on available nitrogen kgha^{-1} of soil at 0-15 cm and 15-30 cm depth

0-15 cm					15-30 cm			
	NPK0	**NPK50**	**NPK100**	**Mean LC**	**NPK0**	**NPK50**	**NPK100**	**Mean LC**
LC0	242.86	244.56	245.74	244.39	245.14	246.64	248.11	246.63
LC50	246.87	248.46	252.53	249.29	249.28	251.48	254.34	251.7
LC100	253.42	254.71	256.38	254.84	255.21	257.6	285.75	257.19
Mean NPK	247.42	249.24	251.55		249.88	251.88	253.73	
	F-test	S.Em(±)	C.D.at 5%		F-test	S.Em(±)	C.D.at 5%	
Due to Inorg. Fertilizers (NPK)	S	0.3403	1.02		S	0.525	1.57	
Due to liq. Consortia (LC)	S	0.3403	1.02		S	0.525	1.57	
Interaction (NPK+LC)	NS	-	-		NS	-	-	

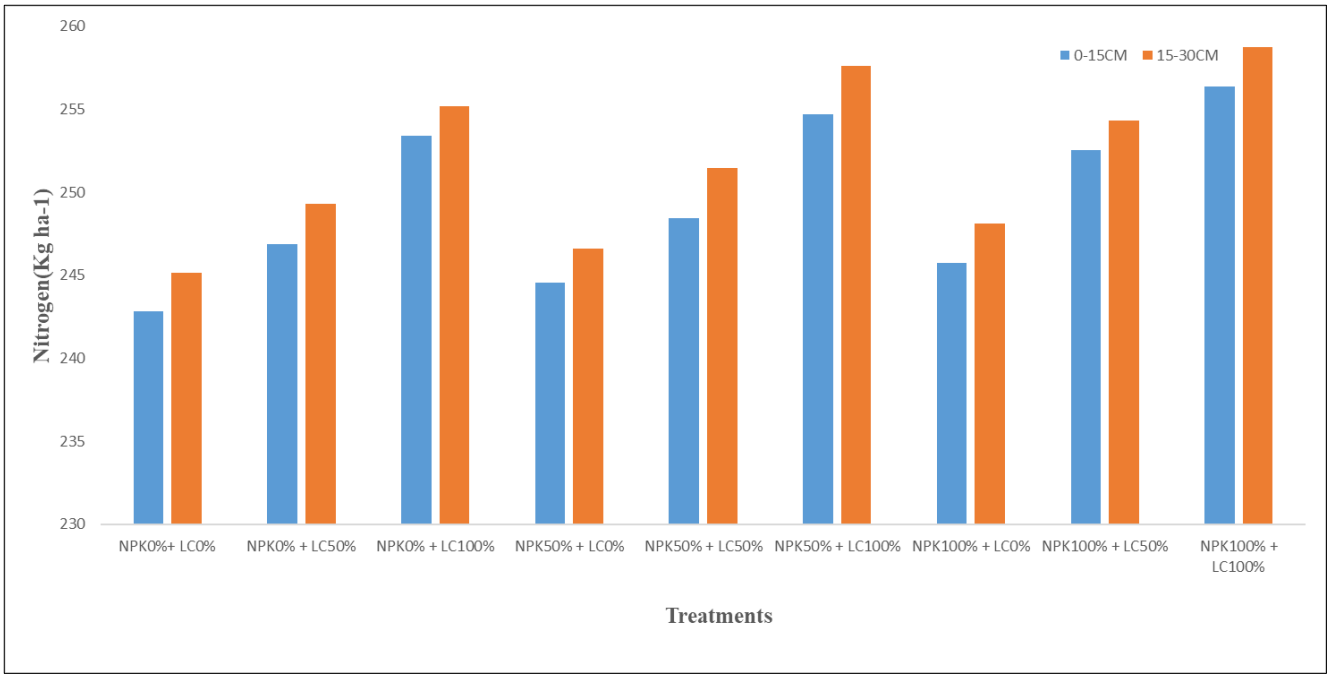

Fig 4: Effect of different levels of inorganic fertilizers and liquid consortia on available nitrogen kgha^{-1} of soil at 0-15 cm and 15-30 cm depth

Table 6: Effect of different levels of Inorganic fertilizers and Liquid consortia on Available phosphorus of soil after crop harvest

0-15 cm					15-30 cm			
	NPK0	**NPK50**	**NPK100**	**Mean LC**	**NPK0**	**NPK50**	**NPK100**	**Mean LC**
LC0	31.3	32.98	32.49	32.26	29.36	31.07	30.58	30.34
LC50	32.11	33.64	37.66	34.47	30.2	31.71	35.75	32.55
LC100	34.35	35.74	39.12	36.4	33.44	33.83	37.21	34.83
Mean NPK	32.59	34.12	36.42		31	32.2	34.51	
	F-test	S.Em(±)	C.D.at 5%		F-test	S.Em(±)	C.D.at 5%	
Due to Inorg. Fertilizer (NPK)	S	0.4642	1.39		S	0.55	1.65	
Due to liq. Consortia (LC)	S	0.4642	1.39		S	0.55	1.65	
Interaction (NPK+LC)	NS	-	-		NS	-	-	

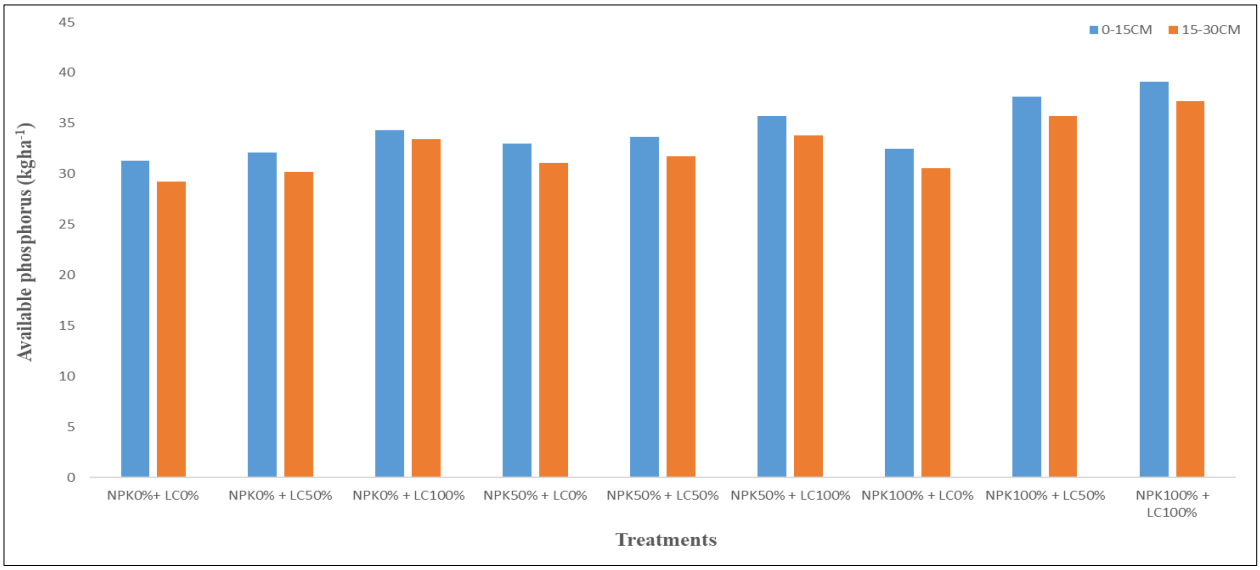

Fig 5: Effect of different levels of Inorganic fertilizers and Liquid consortia on Available phosphorus of soil after crop harvest

Table 7: Effect of different levels of Inorganic fertilizers and Liquid consortia on Available potassium of soil after crop harvest

0-15 cm					15-30 cm			
	NPK0	**NPK50**	**NPK100**	**Mean LC**	**NPK0**	**NPK50**	**NPK100**	**Mean LC**
LC0	130.58	145.65	162.84	146.36	126.64	141.74	158.48	142.29
LC50	138.36	155.64	166.15	153.38	151.29	151.29	162.55	149.4
LC100	146.65	164.54	169.6	160.26	160.36	160.36	165.73	156.71
Mean NPK	138.53	155.28	166.2		135.01	151.13	162.25	
	F-test	S.Em(±)	C.D.at 5%		F-test	S.Em(±)	C.D.at 5%	
Due to Inorg. Fertilizer (NPK)	S	0.472	1.41		S	0.367	1.1	
Due to liq. Consortia (LC)	S	0.472	1.41		S	0.367	1.1	
Interaction (NPK+LC)	S	1.16	2.45		S	0.9	1.91	

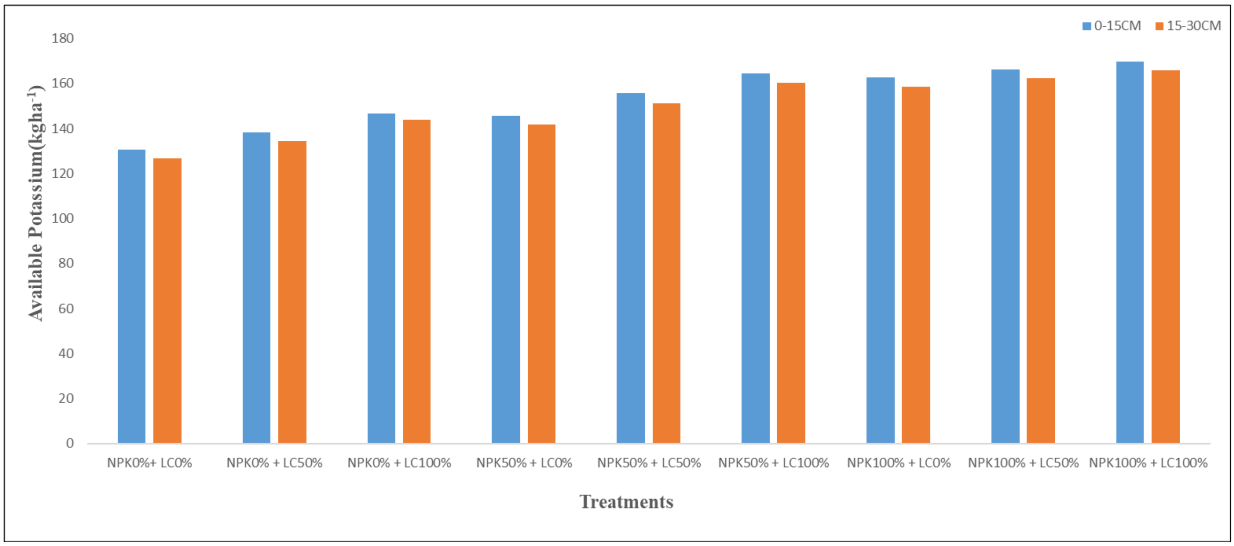

Fig 6: Effect of different levels of inorganic fertilizers and liquid consortia on available potassium kgha^{-1} of soil at 0-15 cm and 15-30 cm depth

4. Acknowledgement
The authors would like to avail this opportunity to thank to the Hon'ble Vice Chancellor, HoD of the Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P. for providing necessary support and essential equipment's for this research work.

5. Conclusion
An experiment was conducted shows that effect of inorganic fertilizer and liquid consortia in T_9 (100% NPK +100% LC) was recorded significantly improved physio-chemical properties of soil including percentage pore space, water holding capacity, available nitrogen, phosphorus and potassium and non-significant is pH. Therefore, it is suggested that T_9 (100% NPK + 100% LC) was observed most suitable for sustainable soil health parameters for green gram to obtained greater yield and economic of the farmers, the trail was based on one season, so that the findings can be justify before recommendation.

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